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CORN CULTIVATION.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., April 28, 1910.

Sir: I have the honor to transmit herewith a paper entitled "Corn Cultivation," and respectfully recommend that it be published as a Farmers' Bulletin.

This paper was prepared by Mr. C. P. Hartley, Physiologist in Charge of Corn Investigations. It originally appeared in the Yearbook for 1903 and has been revised and brought up to date with a view to publication as a Farmers' Bulletin, superseding No. 199, entitled "Corn Growing."

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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CORN CULTIVATION.

POSSIBILITY OF DOUBLING PRESENT YIELD.

It is possible within a few years to double the average production of corn per acre in the United States, and to accomplish it without any increase in work or expense. It is not to be understood from this statement that it is desirable to double the present corn crop, but that it is desirable to produce the same yield on a smaller number of acres and with less labor. If 60 bushels [a] are raised on 1 acre instead of on 2 acres, the labor of plowing, harrowing, planting, cultivating, and harvesting is greatly reduced. The demand controls the quantity that should be grown. To meet demands the producers of the United States have, during the ten years previous to 1910, averaged in round numbers 2,500,000,000 bushels of corn yearly. In producing this quantity a little more than 95,000,000 acres have yearly been devoted to corn growing. The average production per acre has been 26 bushels. Very few farmers would like to acknowledge that their average production for the past ten years has been as low as 26 bushels per acre, but from the best estimates that have been made the conclusion is unavoidable that half of those who grow corn harvest less than 26 bushels per acre. Twice this quantity is a fair crop, three times 26 bushels is a good crop, and four times 26 bushels per acre are frequently produced.

Since the average crop in the States best adapted to corn growing is but little above the general average of the entire country, it is evident that the average is not lowered to any great extent by the poor crops in sections unsuited to corn growing. Moreover, the yield per acre in the New England States, with their poor soil and short growing season, is as great as in any other part of the country. This clearly indicates the possibility of greatly increasing the yield per acre in the corn belt. This is especially easy of accomplishment in the Southern

[a] The laws of the majority of States recognize 70 pounds of ears or 56 pounds of shelled corn as a bushel of corn. These weights are reliable when the ears or shelled corn contain only 15 per cent of water. About one-third the weight of ear corn as customarily harvested in the Northern States is water, while that harvested in the drier sections of the South contains less than 15 per cent of water.

States, where the present production per acre is low and where the growing season is not shortened by frosts.

Poor corn crops are usually attributed to unfavorable weather conditions, and frequently this is the true cause, for there are but few summers during which this crop does not suffer more or less at some stage in its growth. The most that can be done regarding the weather is to take the best possible advantage of the conditions as they exist. But there are other conditions that are responsible for low production—conditions that are directly under the control of the farmer—and it is these that make possible the doubling of the average yield per acre within a few years. Although entirely possible, it is not expected that the near future will witness an average production of 52 bushels for every acre grown. The failure to realize this production will result from the failure of many growers to improve their methods. That some growers in many different States are year by year producing 50 and 75 bushels of corn per acre proves the possibility.

The lines of improvement that will most easily and quickly double the present production per acre are as follows: (1) Improvement in the quality of seed planted; (2) improvement in the condition of the soil; (3) improvement in methods of cultivation.

IMPROVEMENT IN QUALITY OF SEED PLANTED.

Quality improved by seed selection.—As the first of these three ways of increasing production—by improving the quality of the seed planted—is discussed in the Department publications entitled "The Improvement of Corn by Seed Selection,"[a] and "The Production of Good Seed Corn,"[b] it will not be given the space in this bulletin that its importance demands. It is a sure and inexpensive way of increasing production, and is the means that usually receives least attention by corn growers in general. Many farmers who give considerable attention to improving the fertility of their farms and bettering their methods of cultivation take their seed corn from the supply that happens to remain in the crib at planting time without considering that their production is largely dependent upon the quality of seed they plant.

The Department of Agriculture tested the comparative productiveness of ears selected from good yielding stalks in comparison with good ears of the same variety taken from a crib. The field-selected ears produced 16 bushels more per acre, or 20 per cent more than the crib-selected ears.

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[a] Yearbook of the U. S. Department of Agriculture, 1902. A reprint of this paper may be obtained free of charge upon application to the Secretary of Agriculture.

[b] Farmers' Bulletin 229, a copy of which may be secured without cost upon application to the Secretary of Agriculture.

Seed ears selected from the high-yielding rows of an ear-to-row breeding plat produced 18 bushels more per acre, or 16 per cent more than equally fine-looking seed ears selected from a general field of the same corn. The ears of both lots were preserved in the same manner.

Quality retained by proper seed preservation.—The breeding and selecting of high-yielding seed are of great importance. The proper preservation of seed corn is of equal importance.

Four bushels of corn were harvested and divided into two equal parts. One part was well dried and kept dry during the winter in a seed house and the other kept in an ordinary corncrib. In the spring the well-preserved seed was put in one box of a two-row corn planter and the cribbed seed in the other planter box. On rich bottom land planted in this manner the well-preserved seed produced 18 bushels more per acre, or 27 per cent more than the cribbed seed; while on poor upland the well-preserved seed produced 7 bushels more per acre, or 12 per cent more than the cribbed seed. The cribbed seed germinated as well as the well-preserved seed, but the resulting plants were less thrifty and less productive.

Varietal names of little importance.—It would seem strange to publish a general article on corn culture without including something about varieties, but the nomenclature of corn varieties is in such chaos because of mixing of names by seed-corn dealers and the mixing of varieties by cross-pollination effected by the wind, that a varietal name is of little significance in comparison with the vigor, productiveness, and purity of the seed. The Leaming is as constant and well recognized a variety as exists, yet seed ears purchased under this name in Connecticut or New York are, in appearance and productive ability, usually as unlike ears of Leaming purchased in Ohio or Illinois as they are unlike ears of other varieties.

In purchasing seed corn it is wise to give much more attention to the productiveness of a variety, its uniformity, and its adaptability to the soil and climate where it is to be grown than to the varietal name. A variety or strain can be rendered exceedingly productive by proper breeding, but if neglected it soon deteriorates. Careful breeders of productive strains of corn are needed in every community, and growers who do not care to grow a special seed patch and select their seed with care should buy the best seed obtainable. If of the best quality it will be worth $25 per bushel more for seed purposes than unselected corn. A bushel of seed corn will plant 6 acres. Seed of the best quality will increase the yield 10 bushels per acre, thereby increasing the harvest 60 bushels for each bushel of seed planted.

IMPROVEMENT IN CONDITION OF SOIL.

The opportunity for the improvement of the soil offers a wide and inviting field of effort to the intelligent and progressive farmer. While the methods to be adopted vary with the character and condition of the soil, the climatic condition, and the use that is to be made of the land, the general principles involved are here presented in the hope that they may prove helpful to farmers in all sections where corn is grown.

SOME LAND TOO POOR FOR PROFITABLE CORN GROWING.

While it is true that proper attention to seed selection and methods of cultivation will greatly increase the average production per acre

FIG. 1.—Soil too poor for profitable corn growing. Such fields should not again be planted in corn until their fertility is greatly increased.

for all land now devoted to corn growing, it is equally true that the cultivation of corn will never be found profitable on very poor land. Some growers, from force of habit, perhaps, every spring plant corn on land which they know is too poor to produce a profitable crop (fig. 1). While this practice continues, the soil as well as the farmer will remain poor. The plowing and cultivating of poor soil is as expensive as the plowing and cultivating of fertile soil. The man who cultivates poor soil and harvests poor crops can not profitably compete with his neighbor who grows good crops with but little, if any, greater expenditure of labor or capital. Corn growing should not be attempted on poor land until it is brought into a fertile condition by the growing and plowing under of leguminous crops, the application

of manures, etc. In the meantime some crops that require less fertility than corn may be grown. It should be remembered that the nature of the corn plant is such that it will not produce grain unless the soil is rich enough to afford a considerable growth of stalk, and that, in general, the richer the soil the heavier will be the yield of grain. For this reason some other plants will produce fair crops on soil too poor to produce corn. A cotton plant adjusts its yield of lint to the fertility of the soil, a small plant producing a small number of bolls containing lint of as good a quality as that from a larger plant bearing many more bolls. A hay crop is also in quite regular proportion to the fertility of the soil. This is not true, however, of corn. When poor soil dwarfs grass to half its normal size, the crop of hay is reduced by about one-half, but when poor soil dwarfs the corn plants to half their normal size it is probable that there will be no grain yield, or if any ears are produced they will be small and inferior.

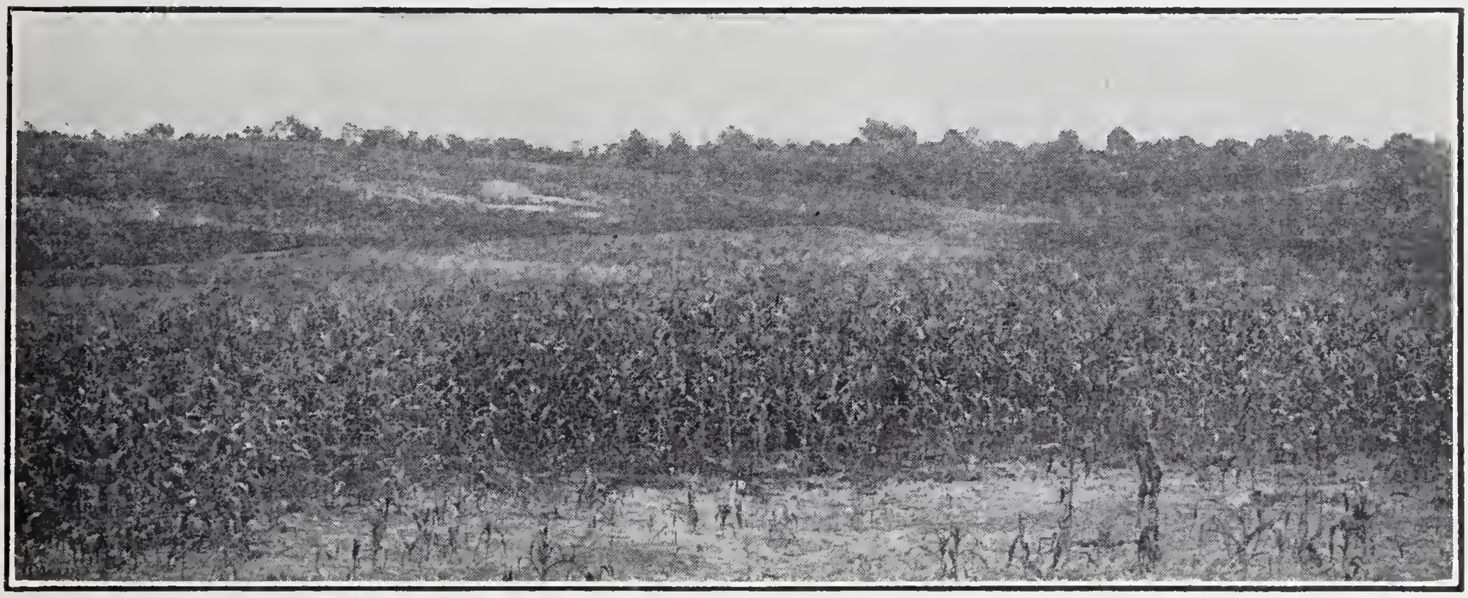

FIG. 2.—Average production reduced by infertile spots.

Even in the best corn-producing States there is some land so poorly cared for that farmers who persist in attempts to grow corn on it receive but little for their labor. Such land, however, in a few years' time can be made to produce good corn crops. The growers who are quickest to learn the futility of attempting to grow corn on impoverished land are those whose farms contain some poor upland fields and some fertile bottom land. They find it necessary to fertilize and renovate the poor fields or confine corn growing to the bottoms. In most regions creek bottoms and river valleys are particularly adapted to corn growing, as they usually have a fertile soil and a subsoil well supplied with moisture.

Another explanation of the low yield per acre on many farms is the amount of unsuited or unimproved areas frequently embraced within the boundaries of fields planted to corn. In many cornfields through-

out the country may be seen portions or spots on which it is impossible for corn to thrive. These may be clayey spots (fig. 2), or swampy or undrained areas (fig. 3), or ground adjacent to timber (fig. 4). It is too great a waste of labor to plow, harrow, and cultivate such unproductive spots. They should be improved so that they will yield a profit, or they should not be planted at all. The poor clay spots should be enriched, the swampy places drained or filled, and the corn should be planted farther from the timber, with a strip of timber grass next to the trees. Many farms could be made more profitable by rearranging the fields in order to make them more uniform as regards moisture and soil fertility, so that the entire field may be treated as the character of the soil may demand. No field can be well tended if the corn rows extend through a portion too wet for cultivation when another portion is in best condition for cultivation.

Fig. 3.—Average production reduced by undrained spots.

SOIL WASHING AND ITS PREVENTION.

Evil effects of soil washing.—More land has been rendered unfit for corn growing by the washing away of the surface soil than by constant cropping. Soil washing must be guarded against if profitable crops are to be harvested from the same field for a number of years, and with proper attention in this respect the farm may be made better year by year. The effect of heavy rains is to wash out gullies and ditches and to carry away the soil and plant food as muddy water. If this is allowed to continue unchecked the lightest and most fertile portion of the soil is carried away and the land becomes less productive from year to year. One heavy rain will sometimes carry away from a field more soil than a man with a team and wagon could restore in a week. It is to be regretted that farmers in the newer and more fertile sections of the country are not as wide awake to the destructive effects

of soil washing as they are in older sections, where the farms have already been injured by the rains of past centuries, and where constant attention is now necessary to retain the fertility which is at considerable expense put into the soil.

Cover crops and terraces.—It should not be supposed that because land is rolling or hilly, washing must take place. Some very hilly sections which have deep porous soils, full of humus, wash but little, and that only when the ground is frozen to a considerable depth and thaws on the surface. Hard soils that do not readily take up the water that falls upon them wash much more than loose porous soils. The most effective means of preventing washing is to cover the soil with vegetation and loosen the subsoil so that the rainfall can penetrate and be absorbed instead of running off. The rows of corn, moreover, should

FIG. 4.—Average production reduced by close proximity to timber.

run at right angles to the direction of the slope. Terraces, when properly placed and well constructed, are effective barriers to soil washing, and their use is to be encouraged. These methods could be profitably employed on the sloping lands near the Ohio and Mississippi rivers. It is the desire of most farmers to have straight corn rows, and on level lands this is preferable, but on hills better success will be obtained by running the rows at the same level around the hills. This will necessitate curved rows, but the curves will usually not be abrupt enough to make cultivation difficult; in fact, cultivation is thus rendered much easier, since it is not necessary to plow up and down the hill, which, to prevent soil washing, should always be avoided.

ABSORPTION OF RAINFALL.

Proper condition of soil.—The carrying away of soluble plant food and lighter portions of soil is not the only objectionable feature of soil washing. The water itself is likely to be needed during some portion of the summer. By loosening the subsoil and covering the surface with a growth of vegetation, the soil can be made so absorbent that the water will penetrate the ground and be held in reserve to sustain the growing plants during times of drought. It would seem that after a period of heavy rainfall, during which 8 or 10 inches of water fell within a month, the soil and subsoil of all fields would be alike saturated, but such is not the case. The condition of the surface soil has much to do in determining how much of the rainfall will be absorbed. The condition of the subsoil is also important. If its moisture has been exhausted by lack of cultivation and injudicious cropping, it will absorb water more slowly than when it is already moist. Thus it is that the subsoil of some fields remains dry to a depth of several feet during a season of heavy rains, while that of other fields absorbs water in sufficient abundance to sustain crops during periods of drought. To readily absorb the water that falls during times of heavy rains the surface soil must be loose and porous, so as to take up the water rapidly before it has time to accumulate, and hold it thus until by capillary attraction it is drawn to the subsoil.

Improvement of subsoils.—Some very fine clay subsoils are so compact that they turn water almost as effectually as a slate roof. Such subsoils should be rendered permeable, and the most effective and cheapest way to accomplish this is by growing deep-rooted plants, such as clovers, alfalfa, melilotus, etc. The roots of these plants penetrate the subsoil and, decaying, leave numerous ducts through which water from the surface soil will pass to greater depths. That this is exactly what occurs is proved by comparisons of plats of ground on which such plants have been grown with adjacent plats on which they have not been grown. The former plats are tillable soon after heavy rains, because the water has found its way into the subsoil, while the latter plats remain muddy on the surface.

Some subsoils are the reverse of those just referred to; instead of being too compact they are too open. A subsoil of coarse gravel may allow the water to pass through too readily, thus washing out and draining away the fertility. Such subsoils are not compact enough to supply the surface soil with moisture by capillary attraction. Soils of this nature are greatly benefited by the plowing under of vegetable matter, which, besides adding greatly to the soil fertility, checks the rapid leaching through the subsoil and enables it to retain moisture better during dry weather. The application of vegetable matter improves the fertility and physical condition of almost all soils, regardless of whether the subsoil is compact or porous.

RETENTION OF SOIL MOISTURE.

Amount of moisture needed by crop.—The amount of moisture needed to produce a crop is much greater than would be imagined. In the case of corn it is sufficient to cover the field with water to a depth of from 10 to 15 inches.[a] About three-fifths of this quantity, or from 6 to 9 inches of water, is absorbed by the roots and exhaled by the foliage of the growing crop.[b] More corn crops are cut short by an insufficient quantity of available soil moisture than by any other cause. This is well demonstrated by the fact that fields situated by rivers or lakes in such a manner that the subsoil always contains sufficient moisture seldom fail to produce good corn crops. The greater portion of the corn-growing area, however, is dependent directly upon the rainfall for its water supply, and it is for this reason that the absorption and retention of water are so important.

Lessening evaporation.—After the soil and subsoil have become well supplied with moisture by the rains of fall, winter, and spring, the next important consideration is the means by which it can be retained in the soil constantly within reach of the growing crop. The effect of sunshine and wind is to cause the moisture to pass rapidly from the soil directly into the atmosphere, and unless cultural methods are employed to lessen evaporation much of the soil moisture will pass into the air without benefiting the crop except in a very slight and indirect way. For the good of the crop as much of the soil moisture as possible should pass into the atmosphere through the plants. In this way it will carry the soluble plant food into the plants, whereas if allowed to evaporate from the surface of the soil it will leave the soluble plant food deposited on or near the surface, where it will be inaccessible to the roots until it is cultivated deeper into the soil or washed there by succeeding rains.

Value of a loose soil mulch.—As the moisture from the surface evaporates it is replaced by moisture drawn from greater depths by capillary attraction, just as oil is drawn through the wick of a lamp to replace that which is consumed by the flame. The rapidity with which moisture will evaporate from the ground depends upon the condition of the capillary tubes or pores that connect the surface with the deeper soil. Any dry blanket that can be placed between the atmosphere and the damp soil will check this evaporation. The most practical protection is a covering of finely pulverized dry soil 2 or 3 inches deep. By thoroughly loosening the surface layer the soil particles are disarranged so that the capillary tubes are not

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[a] Ninth Annual Report, Wisconsin Agricultural Experiment Station, 1892, p. 99.

[b] Experimental Investigations into the Amount of Water Given off by Plants. Rothamsted Memoirs, by Lawes and Gilbert, vol. 1.

continuous. In this condition the surface soil becomes quite dry and remains so without absorbing moisture from below, thus acting as a mulch and retaining the moisture within reach of the plant roots. It is necessary that this soil mulch be fine, for if it is composed of clods air circulates between them and causes evaporation to take place from the soil below the surface. A rain, however, will wet the surface, causing the soil to run together and crust, thus restoring capillarity. This makes another cultivation necessary in order to renew the blanket of fine, loose soil.

FERTILIZERS AND CROP ROTATION.

For increasing the yield of truck crops or high-priced crops grown by intensive systems, the application of complete commercial fertilizers is often highly profitable, because their cost is small in comparison to the price obtained for the produce or in proportion to the price paid for labor and the use of the land. Many of the state experiment stations have issued bulletins on commercial fertilizers, giving formulas for combining the elements so as to adapt the fertilizer in a general way to the soils of their respective States. These will be sent free to those who apply to the director of their state experiment station.

Use of commercial fertilizers.—The question of the chemical fertilizers best suited to increasing the production of corn on the many different kinds of soils that exist in the United States is too broad for discussion here. A soil lacking in fertility can, of course, be made to produce a crop of corn if the requisite amount of nitrogen, potassium, and phosphorus be added and the soil kept in a good physical condition; but the growing of corn on very poor land is usually attended with very little or no profit. It is usually preferable to buy corn rather than to raise it on impoverished soil.

An application of commercial fertilizer may cause a soil to produce one good crop of legumes or other plants, and the roots and foliage of this crop will usually benefit the physical condition and fertility of the soil sufficiently to make other good crops possible without additional applications of fertilizer. The practice to be guarded against is the robbing of the land. As much vegetable growth should be left on the land as judicious management will permit. Soils are not enriched by rest but by producing crops, provided the crops are left on the land.

Important elements of soil fertility.—Of the ten elements necessary to plant growth, nitrogen, potassium, and phosphorus are the ones whose application to soils produces the greatest increase in productivity. Soils composed almost wholly of sand are often deficient in all three of these elements. Soils containing much vegetable

matter are not deficient in nitrogen and usually contain sufficient phosphorus Clay soils may contain sufficient potassium and phosphorus and be deficient in nitrogen. Such soils are made highly productive by growing upon them leguminous crops.

Nitrogen can be added to the soil by applying sodium nitrate, dried blood, tankage, etc., but this element can be more cheaply obtained from the air by growing and plowing under legumes. Potassium can be supplied in the form of potassium chloride or potassium sulphate. Phosphorus can be supplied by applications of ground rock phosphate or ground bone.

If the soil is of such a nature that the application of one or a few elements at a small cost will cause it to produce good corn crops, these elements should be supplied; but if the soil is little more than a foundation, to which must be added a large portion of the necessary plant food, corn growing should be suspended until the soil is permanently enriched by applying large quantities of barnyard manure or by liberal and continued growing and plowing under of leguminous crops. There are many thousand acres of peaty swamp land in Illinois,[a] Indiana, and Wisconsin which, although containing all the elements necessary for plant growth, are caused to produce much more abundantly by application of potassium. Such land produces little or no corn without potassium, but by such an application will produce good crops.

Green manuring with leguminous crops.—Nitrogen, which is an essential element of plant growth and the most costly ingredient of chemical fertilizers, in a free state constitutes four-fifths of the atmosphere. By the aid of microscopic organisms[b] leguminous plants, such as clovers, vetches, beans, peas, and the like, extract nitrogen from the atmosphere and store it in the soil in a form available to succeeding crops. This is one of nature's ways of applying fertilizer, and by working in harmony with nature man can hasten these processes and render poor soils fertile in a few years' time and at but slight expense other than for labor. Soils enriched by the growing and plowing under of leguminous plants retain their fertility well, but no soil, unless it be a river bottom which is frequently renewed by overflows, should be planted to corn year after year. The fertility should be maintained and improved by crop rotation and by the turning under of green crops, which can often be grown the same season with the crop grown for profit.

The plowing under of leguminous crops is here given much emphasis because it is the cheapest way of permanently enriching the large areas existing in almost all the States of the Union, and which each year

[a] Bulletin 93, Illinois Agricultural Experiment Station, 1904, p. 275.

[b] "Bacteria and the Nitrogen Problem," by George T. Moore, Yearbook of the U. S. Department of Agriculture, 1902, p. 333.

yield poor corn crops because of lack of fertility. There are some soils already so filled with decaying vegetation that they are not benefited by this treatment, but such soils are limited in area as compared with the extent of heavy tenacious yellow, red, and black clay soils that respond with increased corn production wherever legumes are grown and plowed under. Almost everyone who has farmed such soils has observed through a cornfield a distinct line of variation in vigor, marking the limitation of last year's clover or alfalfa sod.

Soils that have become so completely exhausted that they will not produce a leguminous crop should be inoculated with the proper nitrogen-gathering bacteria, and should receive manure or commercial fertilizers sufficient to produce a crop of some legume. Cowpeas and soy beans are good crops for very poor land.

No more land should be cultivated than can be rapidly brought to a high state of productiveness. Once in this condition, it produces abundantly enough to yield a profit and maintain its fertility, provided a due proportion is returned to the soil.

Fig. 5.—A Pennsylvania field that produced 130 bushels of corn per acre.

A yield of 130 bushels per acre.—In sections where wheat, oats, or other crops are harvested in early summer, it is almost always desirable to follow them with a soil-improving crop that can be turned under in the fall or the following spring. Clover sod, turned under in the autumn and then torn to pieces and well mixed in the soil by cultivation the next spring, furnishes one of the best seed beds in which to plant corn. This is the method employed by a Pennsylvania farmer, who reports that his yield has not been less than 100 bushels of corn per acre during the past twelve years, with the exception of two seasons. He practices systematic seed selection and also frequent shallow cultivation in a manner well suited to conserve the soil moisture, and is confident that with average rainfall during fall, winter, and early spring he can raise a fair crop without any rain from planting time until harvest. A field of this corn, as seen in August, is shown in figure 5, when it appeared that the yield would exceed 100 bushels per acre. A later report gave 130 bushels as the average yield from 90 acres. Some implements used on this farm are shown in figure 6;

on the left a four-horse or five-horse cultivator, used in the spring for loosening and tearing to pieces the clover sod plowed under in the autumn, and on the right a two-row planter manufactured expressly to make furrows and plant corn according to this farmer's idea of the best method for his farm.

Winter soil cover.—Whatever may be the system of crop rotation, all fields which are subject to blowing or washing of the soil should be kept covered with some crop during the winter. This is usually advisable, even though the field is not subject to blowing or washing, and if the proper crop is grown during fall and early spring it will enrich the soil when plowed under. If oats are to follow a corn crop, clovers, cowpeas, soy beans, velvet beans, wheat, rye, or some other crop should be planted in the cornfield at the last cultivation, or as soon as the corn is cut. Although such crops may not have time to make much growth, they will protect the soil during fall, winter, and

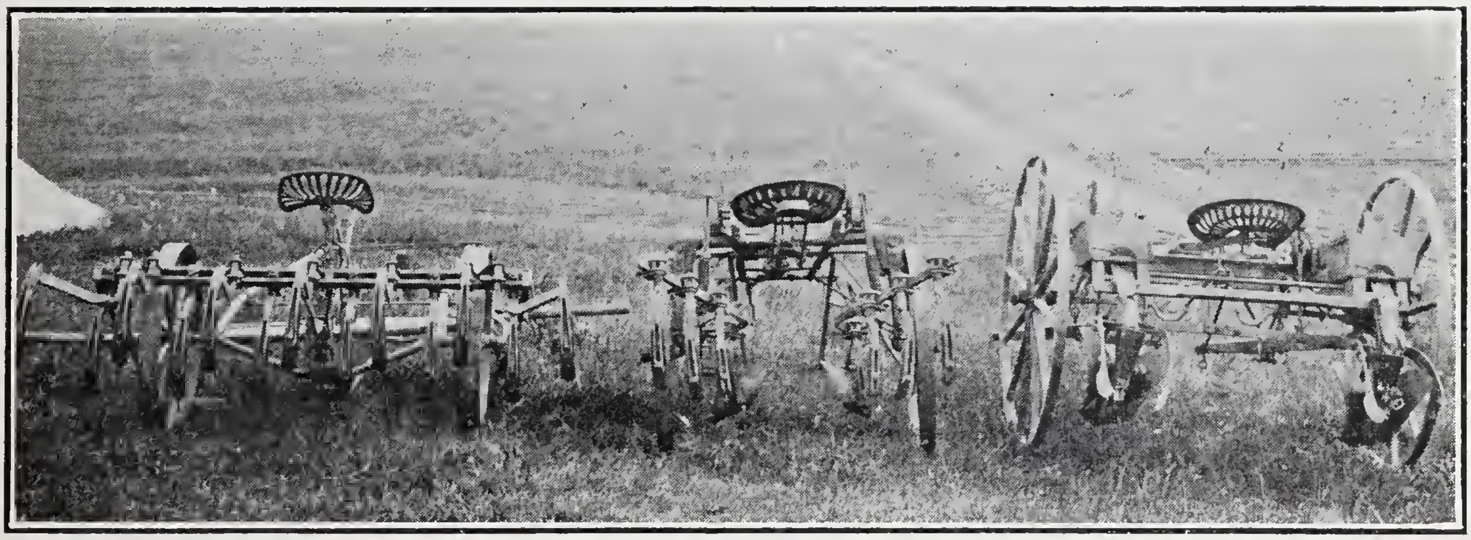

Fig. 6.—Implements used in producing 130 bushels of corn per acre.

early spring, and add to its fertility when turned under or uprooted by cultivation. The growing of beans, peas, clovers, etc., is a great help to the soil even though the seed be gathered or the vines cut for hay, but the turning under of the entire crop enriches the soil to a greater extent and on poor soils causes a very noticeable increase in yield for two or more years.

IMPROVEMENTS IN METHODS OF CULTIVATION.

Practical corn growers will understand the impossibility of giving specific directions regarding the best methods of planting and cultivating corn that would be applicable to any considerable portion of the United States.

GENERAL DISCUSSION OF METHODS.

Adaptation of methods to conditions.—Methods that produce the best results in some States have failed to produce good results in others. Some sections having fertile soils and good rainfall require

for best yields thick planting, while other sections having poor soils or scanty rainfall require thin planting. In some sections with deep soils and subject to prolonged dry weather the best results are obtained by planting in a furrow; while in sections where the land is low and wet, or where the rainfall is excessive, the best results follow when the corn is planted on a ridge. Often adjacent farms possess soils and drainage facilities so different as to demand entirely different methods of cultivation. Rather than attempt to give directions concerning methods best adapted to many various latitudes, conditions of climate and soil, and varieties of corn, some fundamental principles of good corn cultivation, as determined by both practical and experimental corn growers, will be given, leaving it to the judgment of each individual to decide as to which of the principles mentioned can best be adopted in increasing the yield per acre under his particular circumstances.

Learning from experience of others.—The most valuable information regarding the growing of corn in any particular section can be obtained from unprejudiced observant corn growers of many years' experience; and the writer wishes to thank the hundreds who have so kindly given him such information. The fact that the experiences of growers in different localities and the reports of experiments from the various state experiment stations do not agree should not lower the estimation of the value of either. Such disagreement follows necessarily from the different soils, altitudes, latitudes, and seasons. Conflicting published statements have caused some to cease trying to learn better methods from the experiences of others, but a study of the conditions will show good reasons for the conflicting results reported.

Too much conservatism.—The methods of cultivation in general use in one section of the country differ greatly from those in another section. The implements and methods employed in Iowa are as different from those of Connecticut as these in turn are different from those of Georgia; and while these differences are to some extent due to the nature of the farm land or to the class of labor employed, they are to a still greater extent due to the conservatism of the farmers themselves. That certain kinds of cultivators or plows or methods of planting have been in use in Georgia or Iowa for many years does not prove that implements or methods found successful in other States might not be used there to advantage. It is much too common for the majority of growers in a locality to adhere to methods accepted as best simply because they have been followed for years. They often purchase a particular kind of plow, corn planter, or cultivator because it is the one in general use or the only kind for sale by the local implement dealer, without considering whether some other kind might not be better suited to their farms. Merchants and manu-

facturers are so familiar with the methods or machinery of their competitors that any time or labor saving system or device adopted by one soon comes into general use. A similar diligence and enterprise should be exercised by farmers. If every corn grower could visit all the corn-producing States of the Union, the general result would be the discarding of poor and the adopting of improved methods. No section excels in all respects, but almost every section excels in some respect.

In the South Atlantic States the observant corn grower will notice the use of terraces for preventing the washing away of the top soil (figs. 7 and 8). He will also see the advantage of spacing rows and stalks in the rows at distances suited to the fertility of the soil; and, where poor soil necessitates the planting of the rows 6 feet apart, he will perceive the economy of growing a soil-enriching, leguminous plant between the corn rows (fig. 9). On the broad prairies of the

FIG. 7.—Cotton and corn growing on a well-terraced farm in Alabama.

Western States he will learn methods of curtailing expenses by the use of plows, planters, cultivators, and corn harvesters designed so that one man can drive many horses and thereby accomplish a maximum of work. With such implements one man can, without help, plant and care for 40 to 60 acres of corn in addition to his other crops. The same methods and implements are suitable for many farms where more tedious and laborious means are now followed.

FALL PLOWING.

Fall plowing can not be recommended for all soils and localities, but should be more generally practiced than at present. If a cover crop or sod is turned under in the autumn, decomposition will increase the amount of plant food available for the crop next summer. This is true to some extent even though sod is not turned under, inas-

much as the simple loosening of the soil admits atmospheric oxygen and increases chemical action upon vegetable and mineral matter. Fall and winter plowing is one of the best methods of combating

FIG. 8.—Soil washing prevented by terraces.

FIG. 9.—Wide planting, with peanuts between the corn rows.

grubworms, cutworms, and corn-root worms, which are often destructive to corn. Because the surface of ground plowed in the fall is drier at planting time in the spring than that of ground not so

treated, it does not necessarily follow that there is less moisture in fall-plowed ground. The fall plowing has enabled the rainfall better to penetrate the subsoil, thus relieving the surface of its excess of moisture. In the spring, fall-plowed fields usually contain much more moisture, but at the same time have a drier surface than fields which remain unplowed until spring. In sections where there is much rain during the winter it is better not to harrow the fall-plowed land in the autumn. This is especially true of fine clay soils that run together and pack readily. In comparative tests of fall and spring plowing, preceding a dry summer, the fall-plowed fields have generally yielded better. The same is true of subsoiling. Deep spring plowing and spring subsoiling are likely to result in diminished crops, especially if done after the spring rains. The loosening of the soil to great depths admits air and facilitates the loss of soil moisture; it also interrupts the capillarity, so that moisture is not as readily drawn from greater depths, and during a dry summer there is not enough available moisture to support a good crop.

DEPTH OF PLOWING.

From the above it is plain why there has been so much contradictory evidence regarding the best depths to plow for certain crops. For a deep, rich soil deep plowing is best, providing it is done in the fall or does not render the soil too loose and dry. For thin clay soils subsoiling is better than very deep plowing, because it does not turn the compact clay to the surface, yet at the same time loosens the soil to a good depth. The plowing should not be at the same depth from year to year, as by such a practice the soil is not mixed well and a hard surface is left at the bottom of the furrows where the horses walk and the plows drag. A little subsoil turned to the surface occasionally allows the elements to act upon it, liberating plant food, and as it becomes mingled with surface soil and vegetable growth the soil depth will be increased. To accomplish these desired results it is well to plow a little deeper each year for several successive seasons, and then for one season give a plowing at about half the depth of the deepest plowing. The plow should be so adjusted that it will turn all the soil and leave the surface smooth. In every instance spring-plowed land should be pulverized *the same day* it is plowed. It is well to have the farm mapped, the various fields numbered, and records kept of the annual treatment and production of each field.

PLANTING.

Time of planting.—Throughout all the corn-growing sections of the country it is the general experience that corn planted early most often gives the best yield. Occasionally later plantings yield best, but they

are exceptions. In 1902 the writer saw fields of corn in Georgia, planted in February, that yielded 40 bushels per acre, and others adjoining, planted two months later, that did not produce 5 bushels per acre. In the Northern States there is little choice as to time of planting. Corn must be planted as soon as the ground is sufficiently warm, in order that it may mature before early fall frosts. In the Southern States the growing season is long enough to allow planting at different dates, thus lessening the likelihood of having the entire crop cut short by drought. Growing conditions are more favorable in the spring, and corn usually produces better if planted at that time. Although the southern summers are long enough to afford plenty of warm weather, corn planted in the summer will ripen in less time and usually produces less than if planted in the spring. Fields planted early frequently escape attacks of the bud worm, while later plantings of the same year suffer severely. As the result of many years' trials at different state experiment stations the best planting season has been found to be, respectively: Middle Georgia, March 15 to 20; Illinois, May 11 to 18; middle Indiana, May 1 to 11; Kansas, May 2; South Dakota, May 10 to 20. Corn should, of course, not be planted in cold or wet ground simply because the calendar shows that the usual planting time has arrived; but by good drainage, fall plowing, etc., every farmer should strive to have his land in good condition to plant at the proper time.

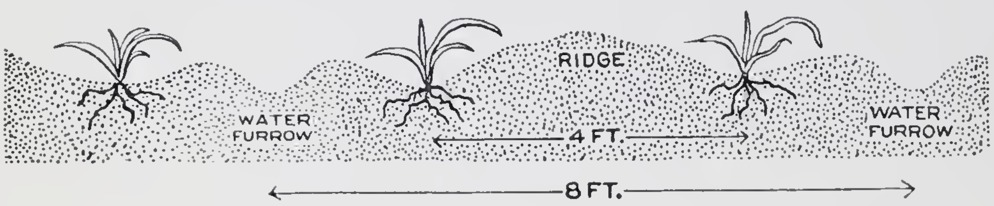

FIG. 10.—Planting system for low, wet land.

Planting low, wet land.—Underground drainage will prove most profitable in the end, but as this is rather expensive it is sometimes desirable to use low, flat land for corn before it is possible to have it tile-drained. Sometimes such fields are plowed in small strips or "lands" 4 to 6 feet wide, and a row of corn is planted on the ridge or backfurrow of every land. This places the plants above surface water, and for this reason is satisfactory during wet weather, but the high situation of the stalks is a disadvantage during dry weather. The method of planting illustrated in figure 10 gives more general satisfaction for such fields. The ground is backfurrowed in lands 8 feet wide, making thereby dead furrows every 8 feet. On each side, and 2 feet from each dead furrow, shallow rows are marked off, and in them the corn is planted. By this method the plants have drainage during wet weather and are better situated for enduring drought than when standing on ridges.

Use of machines.—A little more care can be exercised to advantage as regards dropping a precise number of kernels and covering them

with mellow soil when the planting is done by hand, but the labor saved by the use of planters is so great that for profitable corn growing their use is indispensable. Moreover, if the seed bed is in proper condition any good planter can be made to cover corn as satisfactorily as it can be done with a hoe; and, if seed ears having kernels of uniform size be selected and the small and misshaped kernels at the extremities of the ears be rejected, good modern corn-planting machines can be made to drop with sufficient accuracy for practical purposes. However, the yield depends to such an extent upon the proper number of stalks and their even distribution that too much stress can hardly be placed upon the necessity for selecting seed ears having kernels of uniform size and plates for the planter that will drop the right number at the required distance. Every spring the planter should be thoroughly tested and adjusted until it will drop accurately the seed to be used. The kernels of different kinds of corn vary so much in size and shape that it is necessary to adjust the planter to each kind of corn to be planted. These are some of the many essentials that can be attended to before the rush of planting time arrives.

Depth of planting.—The proper depth to plant must be governed by the quality and moisture of the soil. If it is a stiff, heavy clay containing plenty of moisture at planting time, 1 inch is sufficiently deep; but if it is a light, open, dry soil, 3 or 4 inches is a satisfactory depth. If the corn is planted deeper than 4 inches much of the food supply stored in the seed will be consumed before the young plant can reach the surface and expand its leaves. Plants can not be made to send their roots deeply into the soil by planting the seed deeply. They can better be fortified against dry weather by planting the seed in a furrow, covering it slightly, and then gradually cultivating the furrow full of soil as the plants grow. This requires some care, however, as the furrow should not be filled to any great depth until the plants have attained a height of 2 feet or more and have established their root systems at the desired depth. This method of planting is especially well adapted to deep soils where dry weather is likely to prevail during the middle or latter part of the growing season. The lister, the implement with which a large part of the corn is planted in the Prairie States, fulfills the requirements of this method of planting.

Planting with a lister.—The lister (fig. 11) is used for planting fields that have been thoroughly plowed and also for planting directly in last year's cornfield or stubble field without previous preparation. This latter practice, however, is not recommended for shallow or stiff clay soils.

The results of a majority of the comparative tests in the deep soils of the States just west of the Mississippi River have been in favor of

listed rather than surface-planted corn, and the increased yield of listed plats has been greatest in dry seasons. By planting in a deep furrow, as is done with a lister, weeds in the corn rows are more easily covered by cultivation, and as the furrow becomes filled by cultivation the root system is placed at a greater depth. The corn is thus better enabled to endure drought, and the stalks are not so easily blown down. On soils where corn can be listed without previous preparation of the ground this method is profitable because of the labor saved, but it can be successfully employed only on very deep, loose soils. When the drill is attached to the lister, as is shown in the illustration, one man with three strong horses can do in one day all the work connected with the planting of 7 acres of corn. The drill is so constructed that it can be detached from the lister and used separately. By this means an additional man and horse are required to drill the corn in the furrows made by the lister. If the soil is stiff and heavy it should be well plowed and brought into good condition for planting before the corn is listed. A lister (fig. 11) or a planter with lister attachments (figs. 6 and 12), which lists two rows at once and makes a mark to guide the driver on his return, can then be employed. Disks or double moldboards, similar to those shown, can be attached to the various makes of planters and checkrowers, and thereby the corn can be planted in the bottom of furrows below the general surface of the field. For the reasons mentioned, this method of planting would be an improvement for many localities where extensive areas of corn are yearly planted by means of checkrowers which leave the surface of planted fields smooth.

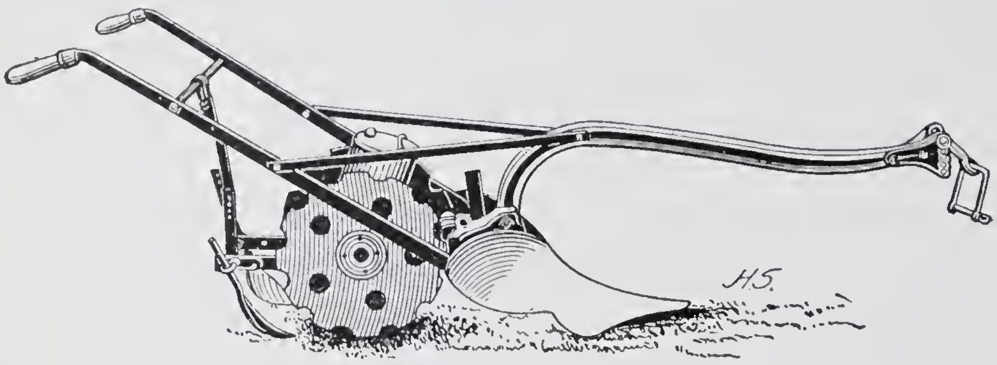

FIG. 11.—Lister with drill attached.

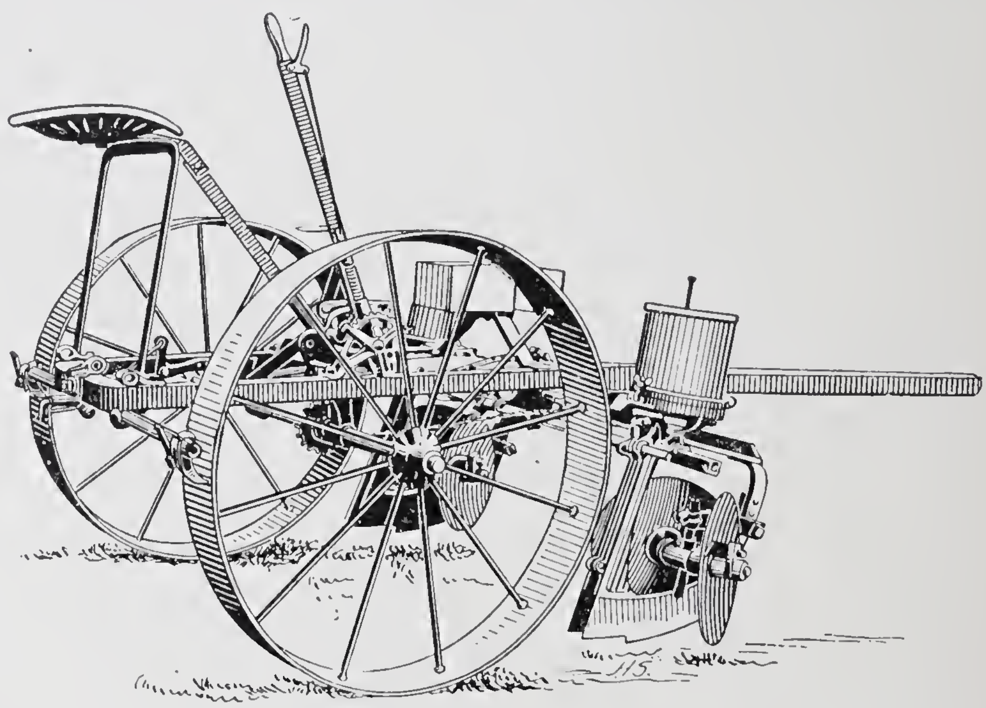

FIG. 12.—A two-row planter with disk attachments for furrow planting.

Planting with a checkrower.—Perhaps more corn is now planted by means of a checkrower than by any other device. This implement is adjustable, so that the spacing of the rows and the distance between the plants or hills in the row can be regulated to suit the requirements of the soil. By means of a wire chain stretched across a field one man and team can plant in straight rows in both directions across the field 12 or 15 acres per day, thus admitting of cross cultivation. Corn planted in this way can be kept free from weeds and well cultivated without costly hoeing or the cutting of weeds. A summary of numerous tests made by various state experiment stations shows that there is practically no difference in yield of corn planted in hills of several stalks each or drilled so that the stalks stand separately in the rows, provided there is the same number of stalks per acre in each case. The former system facilitates cultivation and the latter provides for a more equal distribution of roots throughout the soil. Checkrowers are best adapted to large and comparatively level fields free from trees or stumps. Hillsides and sloping ground can not be planted in checks without increasing the liability to soil washing.

Checking listed corn.—Some successful growers of corn have found it profitable to use a two-row marker set the same width as their checkrower. The checkrower follows in the deep furrows, thus accomplishing all the advantages of both listing and checking.

Distances between rows and hills.—The distances between rows and the stalks or hills in the rows affect to a great extent the production per acre. A proper number of stalks evenly distributed, so that none will suffer from crowding and so that there will be enough to produce the greatest number of well-formed ears, constitutes the best stand for the production of ear corn. If planted thicker than this the weight of stover increases and the production of good ears decreases. If planted thinner the weight of stover, as well as of ears, decreases. Small-growing varieties should be planted thicker than varieties producing tall stalks. The scope of this article precludes the giving of specific directions as to the best distances for planting the various strains of corn, but remembering that for greatest production rich soil requires thicker planting than poorer soil, each farmer must determine the best distances for his particular corn and soil. In 1897, 1898, and 1899 the Georgia Experiment Station [a] obtained the best results by having the rows 4 feet apart, with one stalk every 3 feet in the row. In 1900 the conclusion was reached that for upland soils, capable of producing from 35 to 40 bushels of corn per acre, rows 4 feet apart, with one plant every 2 feet, would yield a larger quantity of grain than any greater or less distance.

[a] Bulletin 51, Georgia Experiment Station, 1900, p. 287.

As an average for nine years the Indiana Agricultural Experiment Station [a] obtained best results from rows 3 feet 8 inches apart, with 1 stalk every 11 inches in the row.

The Illinois Agricultural Experiment Station [b] after five years' tests directs as follows: On ordinary corn-belt land of northern Illinois plant corn hills 36 inches apart with 3 kernels per hill. In central Illinois on land of a productive capacity greater than 50 bushels per acre plant hills 39.6 inches apart with 3 kernels per hill and on land of a lower productive capacity plant hills 36 inches apart with 2 kernels to the hill.

On many farms of slight fertility in the leading corn States of the Mississippi Valley the annual yield is considerably reduced because the corn is planted as thickly as would be advisable on fertile prairie or bottom soils. Here the thinner planting practiced in regions generally less fertile could be adopted with advantage. Corn should not be planted on soil so poor as to necessitate the placing of the rows 5 or 6 feet apart.

The distance for planting in a particular soil should be decided upon and the planter adjusted to plant accurately and regularly. Spots missed by the planter, as well as those depleted by crows, insects, etc., greatly decrease the yield per acre. The custom of planting many times thicker than the stand of stalks desired is not a good one. It is a waste of seed and also of labor to thin or "chop out." If the seed germinates poorly it should not be planted, for although a stand may be obtained by very thick planting the stalks will not be thrifty, and a reduced yield will result from using the poor seed. If the seed shows a germination of 97 per cent or more in a thorough germination test, and it is then properly planted, the stand will be almost perfect, unless very adverse weather ensues, in which case all the plants will be so injured that the planting of the entire field again will be preferable to replanting the missing hills and will be more easily accomplished. It is not only a waste of land to have missing hills in a cornfield, but also a waste of labor in cultivating them. If a field has been drilled in but one direction and for any reason a poor stand is obtained, it can be replanted with a checkrower set to drop one kernel at a time and operated without the tripping chain. The checkrower is driven at right angles to the rows of the first planting and is operated so as to plant just as it crosses each row. For this purpose two men will be required, one to drive and one to trip the checkrower as it crosses the corn rows.

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[a] Bulletin 55, Indiana Agricultural Experiment Station, 1895, p. 26.

[b] Bulletin 126, Illinois Agricultural Experiment Station, 1908, p. 367.

IMPORTANCE OF THOROUGH EARLY CULTIVATION.

The most successful corn growers realize the importance of thorough early cultivation, thus preventing any check in the growth of the plants because of weeds or crusted soil. The farmer should see that, from the time of germination to the maturing of the corn, the plants are not subjected to any unfavorable conditions, but are given an opportunity to make a steady, vigorous growth. If their development is checked from any cause they will never fully recover, no matter how favorable the later treatment. As a consequence of heavy rainfall the stalks may increase rapidly in height, and at the same time, for lack of cultivation or of soil fertility, or for other reason, they may be slender or of poor color. Thrifty corn plants are thick, strong, and of dark green color.

Horse weeders and harrows should be used when needed to break a surface crust, check insect depredations, or kill young weeds that start

FIG 13.—Narrow shovels and fenders for early cultivation.

before the corn is up or large enough to be worked with other implements. During the first cultivation, or while the plants are very small, narrow shovels that throw the soil but very little should be used, and fenders are usually found desirable to prevent the covering of the plants (fig. 13).

DEPTH AND FREQUENCY OF CULTIVATION.

Many comparative experiments of deep and shallow cultivation have been made, and on the whole the results are in favor of shallow cultivation. There are but few occasions when deep cultivation is preferable. If excessive rains have packed the soil and kept it water soaked deep cultivation will help to dry and aerate the soil. Breaking the roots of the plants must be avoided so far as possible (fig 14). If roots are broken the plants will rapidly produce other roots, but it will be at the expense of the vitality and food supply. After the plants have

reached a height of 2 or 3 feet, the soil even in the middle of the rows should not be cultivated deeper than 4 inches, and usually a shallower cultivation will prove better. For retaining soil moisture a loose soil mulch 2 or 3 inches in thickness should be maintained.

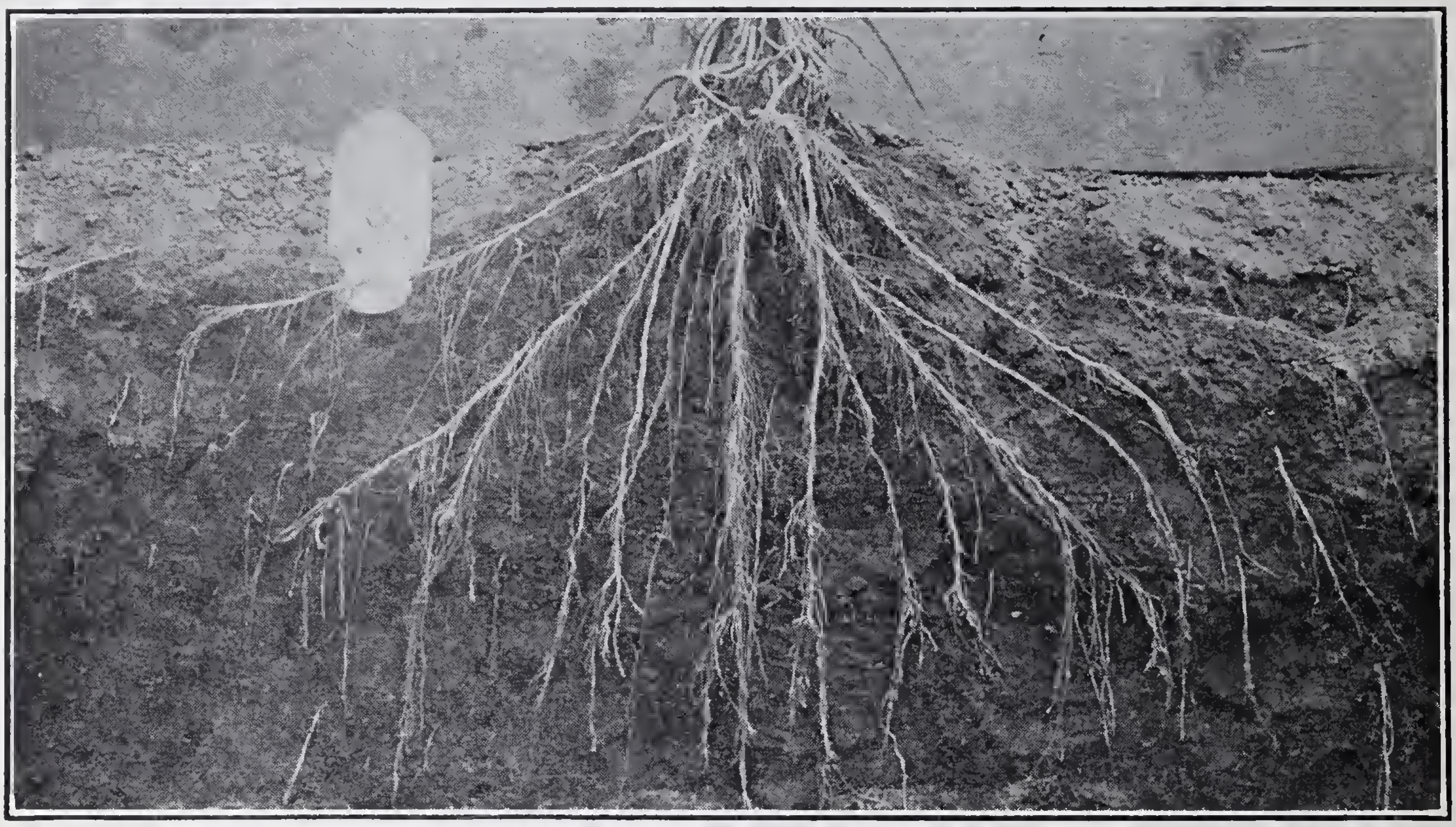

FIG. 14.—Root distribution at silking time. The bottom of the board represents the soil surface.

The best answer to the question of how frequently corn should be cultivated is that it should be cultivated often enough to keep down weeds and to maintain constantly a loose soil mulch till the corn has

FIG. 15.—Injurious results from cultivation after the ground had become too dry.

attained its growth. To this end a greater number of cultivations will be necessary when rains at intervals of about a week cause the surface soil to run together and crust. This crust must be broken and the soil mulch restored, or evaporation will soon rob the soil of

its moisture. It is a mistake to think that the longer the drought the more frequent should be the cultivations. After a fine mulch of about 3 inches in depth has been produced, its frequent stirring is not necessary, except in so far as it is required to keep weeds from starting. The essential object of cultivation is to restore the soil mulch as soon after a rain as the condition of the ground will permit. If this time is allowed to pass and the ground becomes hard and baked dry, the crop will suffer greatly, for the cultivation of hard, dry ground breaks it up into clods, allowing the air to penetrate to greater depth and causing more injury than if such cultivation had not been given at all. All observant farmers have seen crops injured in this manner (fig. 15).

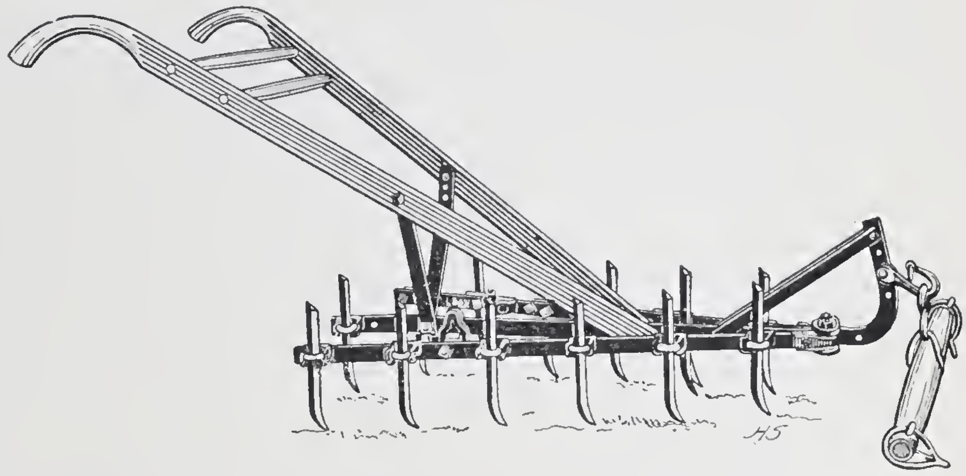

FIG. 16.—Implement for maintaining a soil mulch in tall corn.

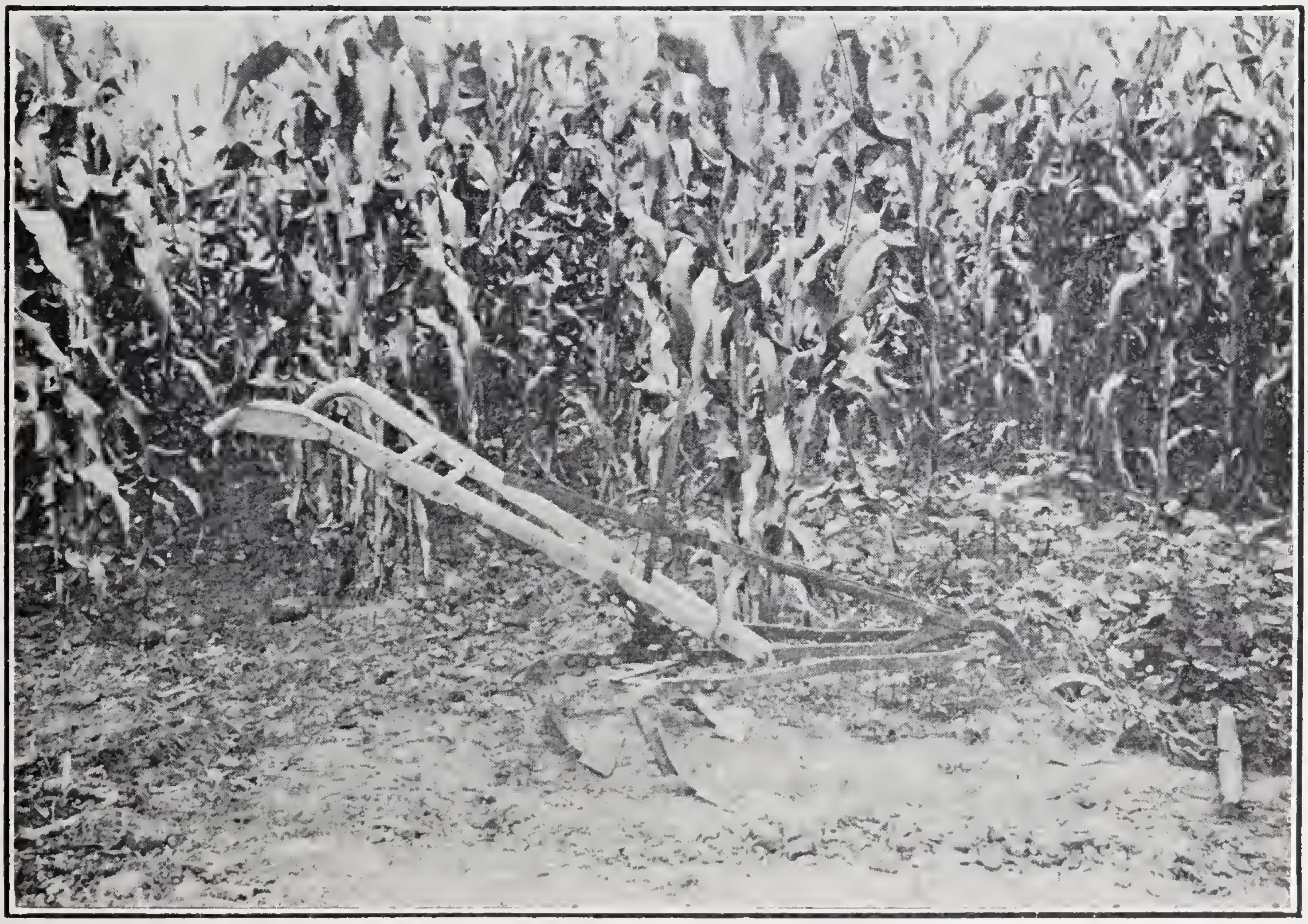

FIG. 17.—A one-horse cultivator well adapted to the shallow cultivation of tall corn.

Many crops are cut short by stopping the cultivation, because the corn is too tall for use of a double cultivator without breaking down the stalks. If the condition of the soil demands it, shallow cultivation should continue, even though the corn is tasseling.

Figure 16 shows a convenient implement which can be used with a short singletree for maintaining a soil mulch after the corn is too tall for the use of double cultivators. Figure 17 shows another which is better adapted to cutting off weeds. The blocks nailed on the handles protect the hands from the corn blades.

Tests made by the Office of Corn Investigations prove that it is sometimes profitable to remove weeds even by the costly process of hand hoeing and even at as late a date as the silking time of the corn.

KINDS OF CULTIVATORS.

With a good riding or walking double cultivator one man can cultivate as many acres as two men with a one-horse cultivator, and with the most improved types he can accomplish the work more easily

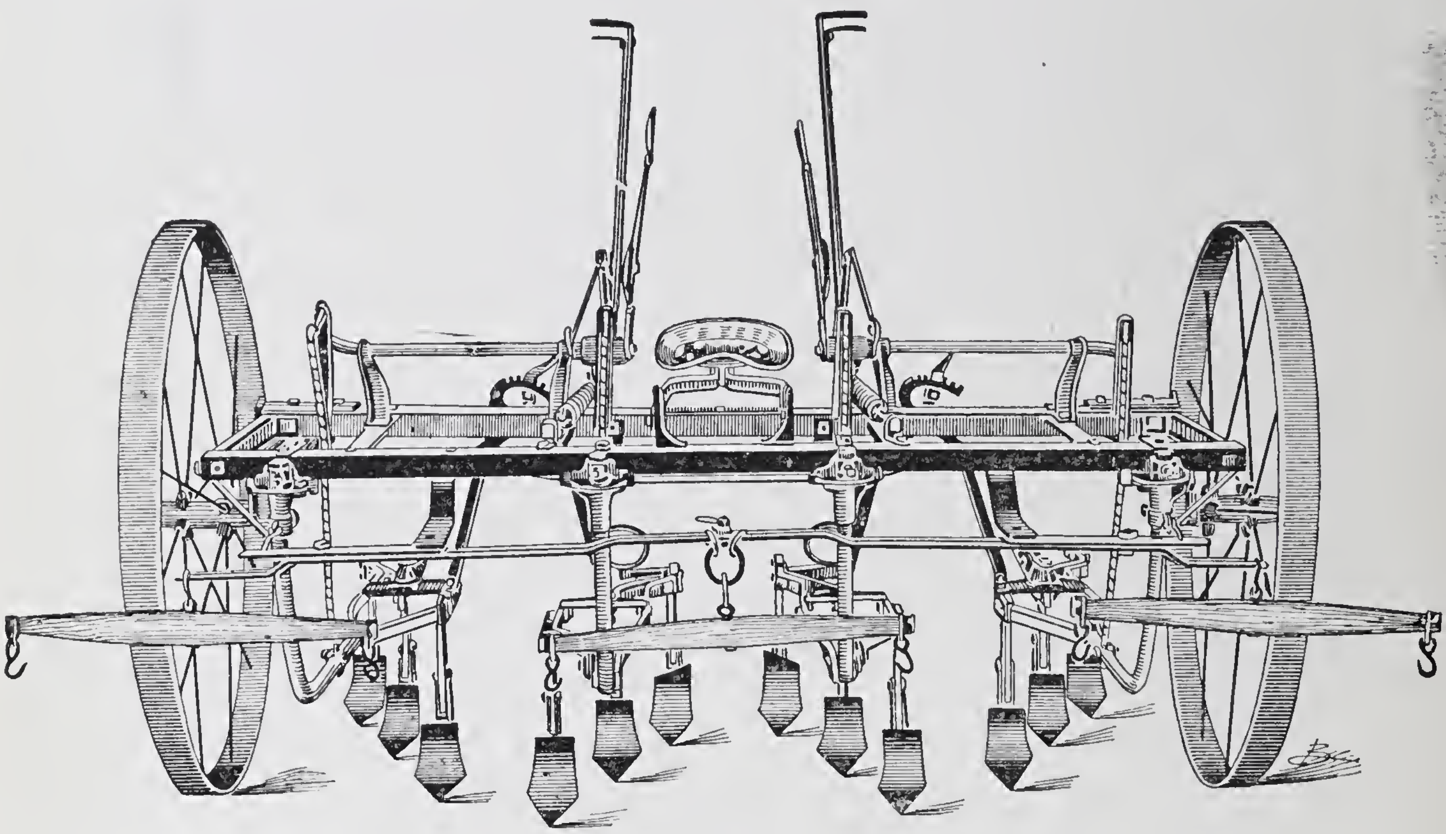

FIG. 18.—A two-row cultivator.

and fully as well. Because of this saving of labor, double cultivators should be used wherever practicable. Two-row cultivators equipped with four gangs of shovels and drawn by three horses are meeting with favor in the central Prairie States. As one of these completes the cultivation of two rows of corn each time it crosses the field, one man can cultivate 15 acres per day. In many sections it is often difficult to obtain laborers when they are needed and, as with these two-row cultivators one man can cultivate as many acres as two men with double cultivators, their use is likely to increase, especially in comparatively level sections free from stumps and rocks where corn is planted by means of two-row planters. Some forms of these two-row cultivators (fig. 18) are mounted on two wheels, like two-horse double cultivators, while others made for plowing listed corn are carried on runners or low, broad wheels designed so as to follow the rows

made by the lister. Three-row cultivators (fig. 19) of this type are used to some extent on large fields free from obstructions. Very stumpy land or tall corn may necessitate the use of one-horse cultivators.

FIG. 19.—A three-row cultivator for listed corn. The broad wheels follow the furrows, thus guiding the disks and fenders.

The kind of shovels with which it is best to equip either single or double cultivators must be determined by the character of the soil, size of the corn, and the size and nature of growth of the weeds to be destroyed. Without exception, any form of shovel found to do good work on a one-horse cultivator can be attached to a double or a two-row cultivator. For light sandy land, sweeps (fig. 20) are in great favor, and are of various widths from 6 to 30 inches. The sweeps scrape along through the soil at a depth of 2 to 3 inches, cutting off weeds, and allowing the surface soil to pass over them and fall level

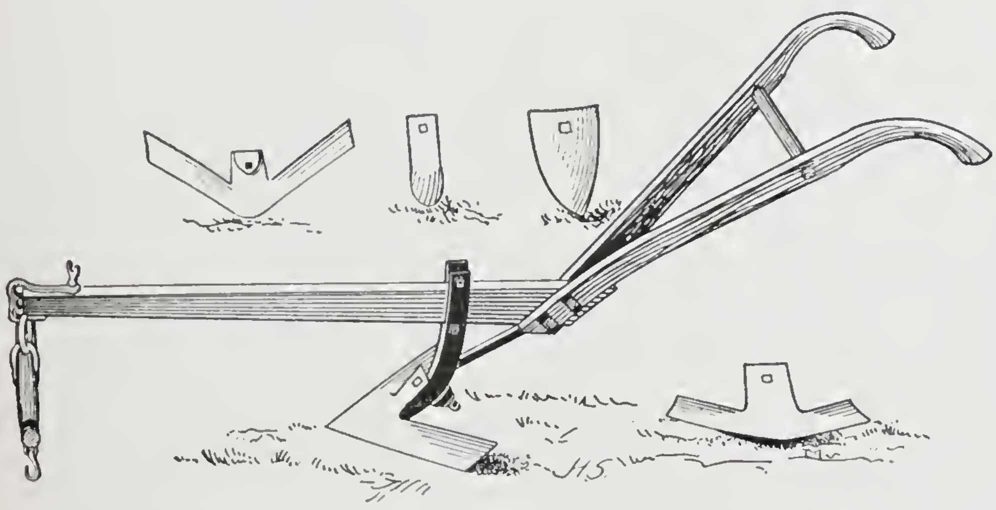

FIG. 20.—Sweeps and shovels used on single and double cultivators.

and flat behind the cultivator. The same results are accomplished with a double cultivator used in New England, where it is known as a

FIG. 21—A horse hoe or hoeing machine.

horse hoe or hoeing machine (fig. 21). This implement was made originally for tobacco cultivation, the long horizontal blades which extend toward the row from the vertical stocks serving well to reach under the tobacco leaves and cut weeds and loosen the soil without breaking the leaves. In the illustration the horizontal blades are under the soil and

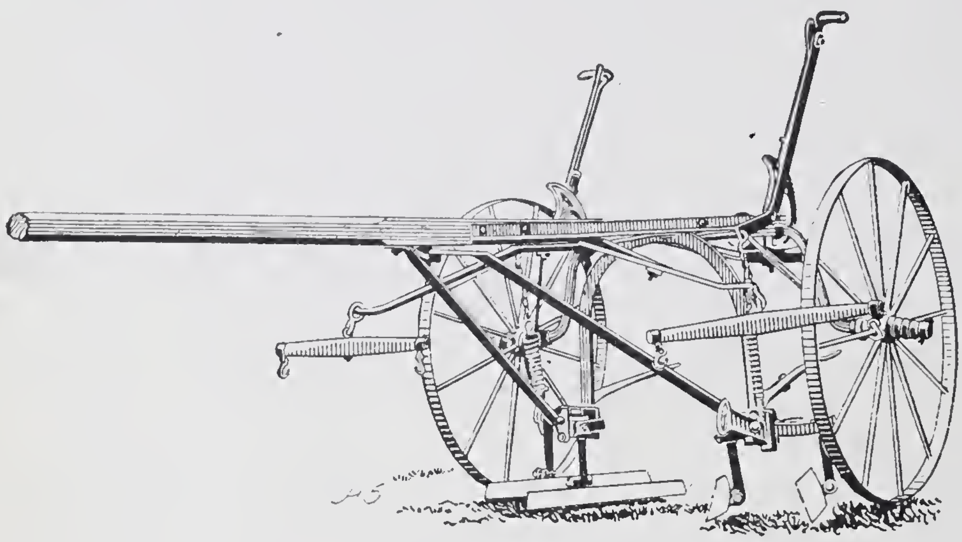

FIG. 22.—Double cultivator equipped for surface cultivation.

FIG. 23.—Surface cultivator and disk cultivator.

can not be seen. Shovels which accomplish the same purpose are used on double cultivators, and in the Central States are called surface

cultivators (fig. 22). In the field shown in figure 23 the surface cultivator was doing better work than the disk cultivator, which left narrow strips of solid soil that were not covered with fine loose soil. All forms of shovels should be so adjusted that the loosened soil will make a fine and even covering for the harder soil beneath. The surface cultivator shown in figure 23 bears two attachments for smoothing the soil behind the shovels. It is a very easy matter to have the local blacksmith so form the cultivator shovels that they will accomplish good results in the kind of soil in which they are to be used. Figure 24 shows shovels modified at the farm blacksmith shop for use on river-bottom land, where bindweed, man-of-the-earth, and other vines and weeds are hard to control. The sharp horizontal blade at the bottom of the shovel strikes the weeds so squarely that there is little chance for them to escape by slipping by either side, as is so common with ordinary shovels.

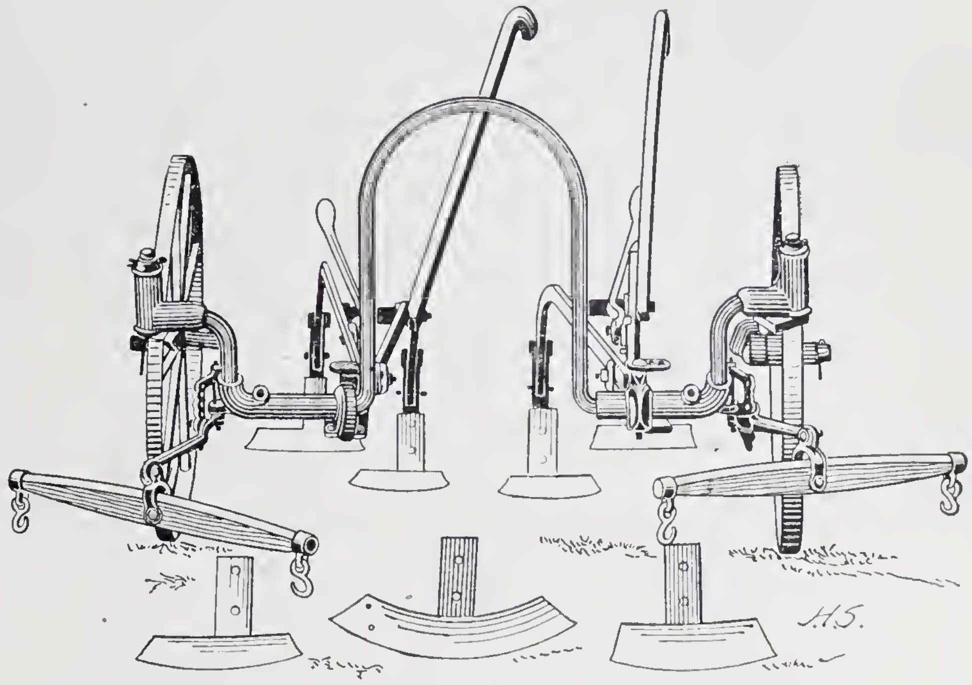

Fig. 24.—Homemade shovels adapted to surface cultivation and weed destruction.


Fig. 25.—A good modern double cultivator.

Almost all styles of double cultivators are made either with handles, as walking cultivators, or with a seat, as riding cultivators. The latest forms of riding cultivators are easily and readily manipulated and do good work. Figure 25 shows a modern cultivator, the shovels of which are shifted in unison to the right or to the left by a straight forward pressure with one or the other foot. Some cultivators, which require lateral pressure with the feet for guiding the shovels, are tiring to the operator. A sunshade adds but little to the cost of the cultivator and makes the work less irksome. Such appliances should not be regarded as devices of the lazy. To do work in a laborious or fatiguing manner when it can be done equally as well and as quickly in a pleasant way is folly. It lessens the laborer's capacity for work by exhausting his energy, so that he can do less than he would be capable of doing were he to perform it in an easier way. No worker is more entitled to the advantages of mechanical devices that will ease his labor or increase his comfort than he who produces the food supply of the world.

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